

What is claimed is:

- 1 1. A method of routing packets in a communications network,
- 2 wherein the network comprises a plurality of nodes which are interconnected
- 3 by parallel component links, the method comprising the steps of:
- 4 a) grouping said parallel component links into a bundled link; and
- 5 b) performing routing calculations according to a link state routing
- 6 algorithm on using said bundled link as a unit of transmission medium.

- 1 2. The method of claim 1, wherein step (a) further comprises the
- 2 step of creating a first database in which a plurality of bundled links are
- 3 mapped to a plurality of component links, and step (b) further comprises the
- 4 step of creating a second database in which a plurality of destination
- 5 addresses are mapped to a plurality of bundled links.

- 1 3. The method of claim 2, further comprising the step of receiving
- 2 data packets arriving on said parallel component links and routing the data
- 3 packets based on said first and second databases.

- 1 4. The method of claim 2, further comprising the steps of:
2 downloading said first and second databases to a plurality of interface
3 units connected to said parallel component links; and
4 receiving data packets arriving on said parallel component links at
5 said interface units and routing the data packets based on said downloaded
6 first and second databases.

1 5. The method of claim 1, wherein step (a) comprises the step of
2 exchanging hello packets between a pair of said nodes via said parallel
3 component links and creating said first database in a learning process based
4 on contents of the exchanged hello packets.

1 6. The method of claim 1, wherein the parallel component links
2 are grouped into a plurality of bundled links corresponding to different ones
3 of said plurality of nodes.

1 7. The method of claim 1, wherein the parallel component links
2 are grouped into a plurality of bundled links corresponding to a plurality of
3 different bandwidths.

1 8. The method of claim 1, wherein the parallel component links
2 are grouped into a plurality of bundled links corresponding to a plurality of
3 different management groups.

1 9. The method of claim 1, wherein the parallel component links
2 are grouped into a plurality of bundled links corresponding to a plurality of
3 different link priorities.

1 10. The method of claim 1, wherein the parallel component links
2 are grouped into a plurality of bundled links corresponding to a plurality of
3 different light wavelengths.

1 11. The method of claim 1, wherein step (a) comprises the step of
2 monitoring status of said parallel component links and grouping said parallel
3 component links into said bundled link when there is a significant change in
4 the monitored status.

1 12. The method of claim 7, wherein step (a) comprises the steps of
2 maintaining a bundled link management table for storing a total bandwidth
3 of said bundled link and grouping said parallel component links into said
4 bundled link according to the stored total bandwidth, further comprising the
5 step of defining a bundled link state according to said stored total bandwidth
6 and performing step (b) according to the bundled link state and the stored
7 total bandwidth.

1 13. The method of claim 5, wherein said bundled link is uniquely
2 assigned an interface IP (internet protocol) address, and wherein said hello
3 packets contain said interface IP address to all neighbor nodes to exchange
4 interface IP addresses.

1 14. The method of claim 5, wherein said first database contains a
2 node identifier identifying a neighbor node and a link identifier assigned by
3 the neighbor node for identifying each of said parallel component links.

1 15. The method of claim 1, wherein each of said nodes is an optical
2 cross-connect system and is arranged to send a signaling packet for
3 establishing a wavelength path in said network, and wherein each of said

4 parallel component links is assigned a common link identifier and said
5 signaling packet contains the common link identifier for allowing neighbor
6 nodes to identify a component link which interconnects the neighbor nodes.

1 16. The method of claim 12, wherein step (a) comprises:
2 responsive to a link-up request, incrementing a number of component
3 links grouped into said bundled link and increasing said by an amount
4 corresponding to a bandwidth of a requested component link;

5 responsive to a link-down request, decrementing said number of
6 component links and decreasing said by an amount corresponding to a
7 bandwidth of a requested component link; and
8 adding a component link requested by the link-up request to said
9 bundled link if the number of component links grouped into said bundled
10 link is greater than zero and removing a component link requested by the
11 link-down request from the bundled link if the number of component links
12 grouped into the bundled link is equal to zero.

1 17. The method of claim 1, further comprising the steps of:
2 transmitting a signaling packet to a downstream neighbor node if an
3 idle outbound component link is available in a first one of the bundled links
4 of the network, said signaling packet containing a transfer list of nodes; and
5 receiving said signaling packet from an upstream neighbor node and
6 setting a connection in a matrix table according to the transfer list contained
7 in the received signaling packet if an idle outbound component link is
8 available in a second one of the bundled links.

1 18. A routing controller for routing packets in a communications
2 network, wherein the network comprises a plurality of nodes which are
3 interconnected by parallel component links, comprising:

4 a link manager for grouping said parallel component links into a
5 bundled link; and

6 a routing module for performing routing calculations according to a
7 link state routing algorithm using said bundled link as a unit of transmission
8 medium.

1 19. The routing controller of claim 18, wherein the link manager
2 creates a first database in which a plurality of bundled links are mapped to a
3 plurality of component links, and said routing module creates a second
4 database in which a plurality of destination addresses are mapped to a
5 plurality of bundled links.

1 20. The routing controller of claim 19, wherein said link manager
2 and said routing module are arranged to download said first and second
3 databases to a plurality of interface units connected to said parallel
4 component links to allows said interface units to translate header of data
5 packets arriving on said parallel component links according to said
6 downloaded first and second databases.

1 21. The routing controller of claim 19, wherein said link manager
2 exchanges hello packets with a neighbor node via said parallel component
3 links and creates said first database in a learning process based on contents of

4 the exchanged hello packets.

1 22. The routing controller of claim 18, wherein the link manager
2 groups said parallel component links into a plurality of bundled links
3 corresponding to different ones of said plurality of nodes.

1 23. The routing controller of claim 18, wherein the link manager
2 groups the parallel component links into a plurality of bundled links
3 corresponding to a plurality of different bandwidths.

1 24. The routing controller of claim 18, wherein the link manager
2 groups the parallel component links into a plurality of bundled links
3 corresponding to a plurality of different management groups.

1 25. The routing controller of claim 18, wherein the link manager
2 groups the parallel component links into a plurality of bundled links
3 corresponding to a plurality of different link priorities.

1 26. The routing controller of claim 18, wherein the link manager
2 groups the parallel component links into a plurality of bundled links
3 corresponding to a plurality of different light wavelengths.

1 27. The routing controller of claim 18, wherein the link manager
2 monitors status of said parallel component links and groups said parallel
3 component links into said bundled link when there is a significant change in

4 the monitored status.

1 28. The routing controller of claim 23, wherein the link manager
2 groups said parallel component links into said bundled link according to a
3 total bandwidth of the bundled link and defines a bundled link state
4 according to the total bandwidth, and wherein the routing module performs
5 said routing calculations according to the bundled link state and said total
6 bandwidth of the bundled link.

1 29. The routing controller of claim 21, wherein said bundled link is
2 uniquely assigned an interface IP (internet protocol) address, and wherein
3 said hello packets contain said interface IP address to all neighbor nodes to
4 exchange interface IP addresses.

1 30. The routing controller of claim 21, wherein said first database
2 contains a node identifier identifying a neighbor node and a link identifier
3 assigned by the neighbor node for identifying each of said parallel
4 component links.

1 31. The routing controller of claim 28, wherein said link manager is
2 arranged to:
3 increment a number of component links grouped into said bundled
4 link in response to a link-up request,
5 increase said by an amount corresponding to a bandwidth of a
6 component link requested by the link-up request,

7 decrement said number of component links in response to a link-down
8 request,
9 decrease said by an amount corresponding to a bandwidth of a
10 component link requested by the link-down request,
11 add a component link requested by the link-up request to said
12 bundled link if the number of component links grouped into said bundled
13 link is greater than zero, and
14 remove a component link requested by the link-down request from the
15 bundled link if the number of component links grouped into the bundled link
16 is equal to zero.

1 32. The routing controller of claim 18, wherein the link manager is
2 arranged to:
3 transmit a signaling packet to a downstream neighbor node if an idle
4 outbound component link is available in a first one of the bundled links of the
5 network, said signaling packet containing a transfer list of nodes; and
6 receive said signaling packet from an upstream neighbor node and
7 setting a connection in a matrix table according to the transfer list contained
8 in the received signaling packet if an idle outbound component link is
9 available in a second one of the bundled links.

1 33. A router for routing packets in a communications network,
2 wherein the network comprises a plurality of said router which are
3 interconnected by parallel component links, comprising:
4 a routing controller;

5 a plurality of interface units connected to said parallel component
6 links; and

7 a switch for switching an inbound hello packet from said interface
8 units to said routing controller and an outbound hello packet from the
9 routing controller to said interface units and switching a data packet between
10 said interface units,

11 said routing controller grouping said parallel component links into a
12 bundled link according to a link-up or a link-down request and producing a
13 first database and performing routing calculations according to a link state
14 routing algorithm using said bundled link as a unit of transmission medium
15 and producing a second database,

16 said interface units translating header of said data packet according to
17 said first and second databases.

1 34. The router of claim 33, wherein the routing controller creates
2 said first database by mapping a plurality of bundled links to a plurality of
3 component links and downloads the first database to said interface units, and
4 creates said second database by mapping a plurality of destination addresses
5 to a plurality of bundled links and downloads the second database to said
6 interface units, wherein each of said interface units translates header of said
7 data packet according to said downloaded first and second databases and
8 transmits the header-translated data packet to said switch.

1 35. The router of claim 33, wherein said routing controller creates
2 said first database in a learning process based on contents of the exchanged
3 hello packets.

1 36. The router of claim 33, wherein said routing controller groups
2 said parallel component links into a plurality of bundled links corresponding
3 to different ones of said plurality of routers.

1 37. The router of claim 33, wherein the routing controller groups
2 the parallel component links into a plurality of bundled links corresponding
3 to a plurality of different bandwidths.

1 38. The router of claim 33, wherein the routing controller groups
2 the parallel component links into a plurality of bundled links corresponding
3 to a plurality of different management groups.

1 39. The router of claim 33, wherein the routing controller groups
2 the parallel component links into a plurality of bundled links corresponding
3 to a plurality of different link priorities.

1 40. The router of claim 33, wherein the routing controller groups
2 the parallel component links into a plurality of bundled links corresponding
3 to a plurality of different light wavelengths.

1 41. The router of claim 33, wherein the routing controller monitors
2 status of said parallel component links and groups said parallel component
3 links into said bundled link when there is a significant change in the
4 monitored status.

1 42. The router of claim 33, wherein the routing controller groups
2 said parallel component links into said bundled link according to a total
3 bandwidth of the bundled link and defines a bundled link state according to
4 the total bandwidth, and performs said routing calculations according to the
5 bundled link state and said total bandwidth of the bundled link.

1 43. The router of claim 33, wherein said bundled link is uniquely
2 assigned an interface IP (internet protocol) address, and wherein said hello
3 packets contain said interface IP address to all neighbor nodes to exchange
4 interface IP addresses.

1 44. The router of claim 33, wherein said first database contains a
2 router identifier identifying a neighbor router and a link identifier assigned
3 by the neighbor router for identifying each of said parallel component links.

1 45. The router of claim 42, wherein said routing controller is
2 arranged to:
3 increment a number of component links grouped into said bundled
4 link in response to a link-up request,
5 increase said by an amount corresponding to a bandwidth of a
6 component link requested by the link-up request,
7 decrement said number of component links in response to a link-down
8 request,
9 decrease said by an amount corresponding to a bandwidth of a
10 component link requested by the link-down request,

11 add a component link requested by the link-up request to said
12 bundled link if the number of component links grouped into said bundled
13 link is greater than zero, and
14 remove a component link requested by the link-down request from the
15 bundled link if the number of component links grouped into the bundled link
16 is equal to zero.

1 46. The router of claim 33, wherein the routing controller is
2 arranged to:
3 transmit a signaling packet to a downstream neighbor node if an idle
4 outbound component link is available in a first one of the bundled links of the
5 network, said signaling packet containing a transfer list of nodes; and
6 receive said signaling packet from an upstream neighbor node and
7 setting a connection in a matrix table according to the transfer list contained
8 in the received signaling packet if an idle outbound component link is
9 available in a second one of the bundled links.